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DESIGN OF TECHNOLOGIES FOR RECYCLING INDUSTRIAL WASTE INTO MICRO FERTILIZERS

BAZARBAYEVA SAULE MARATOBNA

Professor, Vice-President of Kazakh-Russian International University, Aktobe, Kazakhstan

ABSTRACT

In the paper we present new components and methods for processing of bore-containing wastewater into micronutrient fertilizers. The advantage of the solution is the development of technology for the processing of waste and the modified structure, contributing to improve the economic and ecological index of micronutrients production from bore compounds at lower costs for raw materials.

The new composition is a solution for pre-seed treatment (soaking) and foliar feeding of plants (spraying). The novelty is that as micronutrient fertilizers applied neutralized with alkali, bleached and diluted bore-containing wastewater.

To enhance the effectiveness resulting micro fertilizers (modifications) in solution was further added complexion bore - polyols.

Efficient ways of recycling industrial bore wastes of Aktobe region on micro fertilizers are under study and the results of research are presented. We can reduce industrial expenses due to the usage of wastes.

KEYWORDS: Micro Fertilizer, Technology, Processing of Waste, Bore Compound, Complexion Bore, Polyol Alcohol, Sludge, Biomass of Green Seedlings, More Efficient Composition, Reduction of Costs for Raw Materials, Increasing Crop Yield

INTRODUCTION

One of the most important factors of growing agricultural products using intensified technology is to enrich soil by chemical fertilizers, which nowadays there is not enough amount of it in Kazakhstan. The only plant in the region for the producing mineral fertilizers was former operating Alga chemical plant after Kirov (Alga, Aktobe region). There are no enterprises engaged in producing agricultural fertilizer in the western Kazakhstan.

Meanwhile, economically viable and environmentally established recycling wastes of certain production and their use as a fertilizer, and there are many examples of their effective use.

So, in the work [1] there is partial solving of the problem polluting environment by phosphorus waste, which provides a method of processing heat-treated phosphate dust fines to produce phosphorous fertilizer at reduced flow of acid reagent.

Groundwater is polluted and poisoned by phosphogypsum dumps, cinder, and halite. Phosphogypsum contains up to 0.5 % phosphoric acid, unwashed and therefore can be used as fertilizer. Pyrite cinders can be used as fertilizers containing copper.

Necessary micro fertilizer for plants is also a bore. It is known [2-4] that bore-containing substances are used, along with other fertilizers, to increase productivity, improve the quality of seeds and plants of various properties (strength

of flax fibers, sugar, starch, etc.), elimination of plant diseases (e.g. internal suberization of fruits and dieback, rot heart beets, flax bacteriosis), ripening of some crops (cotton and corn), and increased winter hardiness.

There is bore in the black soils and red earths, respectively, about 0.20 - 0.25 and 0.10 - 0.15 mg per 1 kg of plants (wet weight), respectively, for grains and root crops. From the data that cultivated soil may lack bore. Mainly due to a lack of bore is the destruction of biological membranes in plant cells. Lack of bore has an inhibiting action on hydrocarbon and protein metabolism, reducing the rate of oxidation of carbohydrates and the synthesis of cellular proteins.

Norm for application to the soil is sufficiently small, only 3-9 g/l (based on boric acid), and for surface application several times smaller (that is in small doses, as micro fertilizer).

However, the above compounds of bore-containing fertilizers have the following disadvantages:

- In all compositions are used relatively expensive by-products of bore ore, which in turn increases the cost of fertilizers;
- Bore fertilizers are not taken in combination (supplements) with other substances - accelerating the growth of plants, which may result as a result of synergies (synergies of their actions), to increase the effectiveness of micronutrients.

It is known [2] that the treatment in the Almaty region spraying tomato plants were 0.002 % boric acid (H_3BO_3) in a phase of mass flowering at the optimum dose of 25 ml/m^2 resulted in a marked increase biometric performance and yield of this crop. Leaf area, compared to the control experiment, increased by 12.00 %, the early harvest of the growing season rose by 8.33 % and 4.48 %. Net additional income was 132 $/ga.

The described method also has disadvantages (additional to the above method):

- Use a clean, expensive and boric acid for about 1000 dollars per ton.
- Not optimized conditions of bore-containing micronutrients usage in different periods of their growth.
- Not taken into account ecological and economic indicators of production, as in the case of pure (commodity) boric acid is applied in a production environment when receiving H_3BO_3 significant damage as a result of pollution and land acquisition for slurry reservoir, soil salinity near them and seepage of sewage sludge tanks into groundwater and water surface.

The aim of further research is developing inexpensive and more efficient composition and working of acidic waste water containing bore as bore micronutrients (BMN) in combination with BMN with various additives that increase the effectiveness of the BMN.

AN EXPERIMENTAL PART

The technical solution is achieved as follows: acid bore wastewater (from evaporation ponds Alga chemical plant Alga, Aktobe region) to neutralize alkaline reagents (calcium oxide, alkali metal hydroxides) to the value of pH (pH=6:7), the solution clarified in order to lighten and then later use. After that bore-containing wastewater is diluted with water and to enhance the action BMN added to this solution complexion bore – polyatomic alcohols (xylitol, mannitol, etc.) at a molar ratio of bore to alcohol, at least 1.0: (1.0 - 2.0). The resulting composition (solution) was used as BMN to gain seed material or foliar feeding plants.

The advantage of the solution is not only a method of recycling, but also the development of compositions,

contributing to improve the economic and environmental performance of the production of micronutrients bore compounds at lower costs for raw materials.

The new composition is a solution for pre-seed treatment (soaking) and foliar feeding of plants (spraying). The novelty is that as micronutrient fertilizers applied neutralized with alkali, bleached and diluted bore-containing wastewater.

To enhance the effectiveness resulting micro fertilizers (modifications) in solution was further added complexion bore - polyols.

To confirm the effectiveness of conservation measures carried out additional calculations associated with the processing of bore-containing wastewater into micronutrient fertilizers.

Expected profit or ecological and economic efficiency in the volume of processed waste water 10^4 m^3 per year, 50% overhead and the conditional price of 0,3 $ per liter micronutrients, will be: 10^4 x 10^3 x 0,3 x 0.5 = 1.5 mln $ a year.

The peculiarities of composition is that in the waste water being of various substances (concentrations shown in Table 1), which can further improve the quality of the BMN. In particular, as shown in table 1, these substances are potassium, phosphorus, magnesium, and others.

Table 1: The Compound of the Clarified Water and Neutralized Tailings and Evaporation Ponds Alga Chemical Plant (Alga, Aktobe Region). Concentration in mg/ l

Substance	Concentration	Substance	Concentration
Carbonate	Not found	Calcium	14,0
Chloride	0,297	Magnesium	11,70
Sulfate	1,430	Sodium	14,20
Fluorine	0,60	K_2O	760,0
Bore	700-1000	P_2O_5	55,0

Since the literature indicates that bore is needed only in a period of growth, and in maturity is not needed, and given the fact that bore compounds give a chance more than 2-3 times per 1 unit of input (in this case it is possible for even greater gains through the use of waste and reduction of production costs), were selected as the cheapest way to foliar fertilization (spraying) and the method of soaking the seeds.

Example 1. Wastewater were neutralized with sodium hydroxide with stirring until pH=6 and desilted. The clarified solution was diluted 10 times, and then soaked in it the seeds of radish (cultivar pink with white tip) before seeding for 6 hours. In a control experiment seeds were soaked by distilled water. At the end of the growing season increased yield of roots was 15 %.

Example 2. Wastewater neutralized to calcium oxide pH=7, desilted, clarified and diluted 10 times with water. The seeds of radish varieties "white" before sowing soaked in BMN for 3 hours. Yields radish "white" increased by 11% and increasing nutrients (based on wet weight of roots) compared to the control was: cellulose - 2.65 %; protein - 3.5 %; sugar - 3.05 %; starch - 0.4.

Example 3. Wastewater treated calcium oxide and diluted 10times, as described in Examples 1 and 2. During the growing season plants beet "table variety" was sprayed during a time in order to BMN foliar feeding rate of 0.1 per 1 m^2 of bore. At the end of the growing season beet yield increase over the control report was 29 %.

Example 4. Soak the seeds of cucumbers and melons in the BMN in Petri dishes in the manner described in Example 1, increased germination of cucumber by 10 % and 20 % for melons.

Example 5. In the condition of cultural farming is a constant removal of bore as a micro element from the soil, so it is promising to use the waste water for pre-production of bore treatment of wheat seeds.

Experiments were carried out with the culture of wheat by the method described below; the origin was taken known method [3] of the determining of germination and seed vigor.

Wastewater plant bore, after neutralization and clarification with bore 0.7 g/l in different quantities, a measured calibrated micropipette, was mixed with 15 ml of water for irrigation, added 2.5 g of grain (50 pieces) and was placed on the filter paper in Petri dishes. Dilution of waste water is obtained in 90 times. Calculations showed that the concentration of ions CI^-, $SO_4{}^{2-}$, F^- , Ca^{2+}, Mg^{2+}, Na^+ does not exceed the maximum permissible concentration in water used for irrigation.

Observations of the number of germinated seeds were conducted in time, compared to the control experiment, for 10 days. As the drying solution in the irrigation water is added to it, which does not contain bore. As irrigation water was taken Aktobe tap water.

Each experiment was carried out simultaneously in four repetitions, and then calculates the average. Found that during seed development occurs under optimal dilutions and additions bore wastewater statistically significant improvements in biometric indicators of growth. Germination increased by 1.5 times, and the germination in 2 times.

Optimal concentration BMV is 0.075 ml per 1 g of seeds. The bore content in the grain was no more than 7.5×10^{-2} mg/kg, which is very small compared to its natural content in cereals (2 mg/kg).

Example 6. The experiment was conducted as described in Example 5 on the seeds of the varieties cultivated solid "Nakat".

The positive effect of optimal doses of BMN seen except vigor and germination, and other indicators: the length of stems and roots, their quantity, weight and quality. For example, after 9 days of germination in Petri dishes under optimal dose of 0,075 ml per gram of wheat seeds in comparison with the control, the length of seedlings increased 3-4 times (see table 2).

More developed one was also soaking the roots, stem thickness is increased, and the mass of green seedlings was more than the control experiment by 3.5 times.

Table 2: Effect of Bore Doses Micro Fertilizers BMV on the Length of Seedlings of the Cultivar "Nakat"

№	Dose BMN, ml/g	L, sm	№	Dose BMN, ml/g	L, sm
1	0(control)	5,2+1,2	4	0,075	18,6+0,8
2	0,300	2,3+1,2	5	0,037	12,5+1,0
3	0,150	2,4+0,5	6	0,018	5,7+1,3

Example 7. BMN efficiency increases significantly when added to a solution of the complexion of bore - a polyol (e.g. .xylitol). Some biometric indicators of wheat seeds under the joint action of xylitol BMN and increases to 5.5 times.

All polyols are non-toxic compounds, and safe for the environment and humans, therefore, established fact of their positive effects should be used in the agrochemical technology of growing plants. Water-soluble polyhydric alcohol is isomers hexahydric alcohols - xylitol, mannitol, sorbitol, and triatomic alcohol - glycerol.

Data on the effect of polyatomic with BMN on biometrics indicators of wheat are shown in Table 3 (the tenth day of germination in Petri dishes, BMN 0,075 ml dose of 1 g of seeds).

Table 3: Effect of the Addition of Polyatomic Alcohol (PA) to the BMN on the Length of Sprouts (LS), the Length (LR) and Number (NR) Roots of the Cultivar "Nakat"

№	Type of Polyatomic Alcohol	Molar Ratio B: Alcohol	The Length of Sprouts (sm)	The Length of Roots, sm	Number of Roots
1	Glycerol	1:1,0	12,1+0,7	11,6+0,5	5,1+0,2
2	Mannitol	1:1,5	18,0+0,5	15,2+0,8	6,7+0,7
3	Xylitol	1:2,0	22,1+0,9	17,6+0,6	10,6+0,6
4	Sorbitol	1:2,0	21,2+1,1	16,2+0,5	9,2+0,9
5	Control	Without PA	4,7+1,3	3,2+0,5	2,0+0,3

As shown in Table 3, the combined effect of BMN and the polyol on the growth of wheat seeds is much higher than adding only BMN. Biometrics increased by 4-5 times, and in the experience of number 3 with xylitol, the length of the roots compared to control experiment № 5 has increased by 5.5 times.

Thus, we propose a new structure of bore-containing micronutrient fertilizers, the essence of which is that in order to increase the yield and plant biomass, process and reduce the cost of waste management, waste water acidic bore reagents to neutralize alkaline pH=6-7 value.

The solution defecated, lightened and to enhance the action BMN added complexing bore - a polyol with a molar ratio of bore to alcohol is at least 1: (1.0-2.0).

Process flow diagram of bore-containing waste water disposal for micronutrient fertilizers is shown in Figure 1.

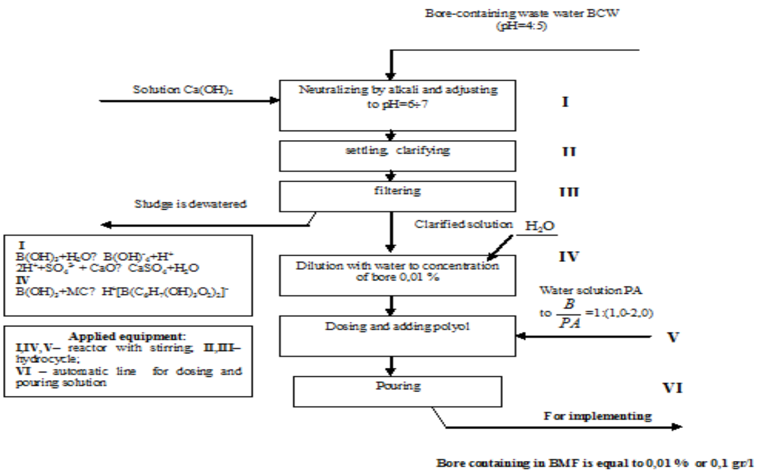

Figure 1: Process Flow Diagram of Bore-Containing Waste Water Recovery on Micro Fertilizers

Technological process of the network (Figure 1) was tested in the laboratory and field conditions. In the case of the technology introduction on an industrial scale for the specified stages of rational use of conventional equipment used widely: for stages I, IV, V and stirred tank reactor for II and III - thickeners and hydrocyclones: for VI stages - automatic line for dispensing and filling solutions [5].

To neutralize the acidic water should be used CaO - dusty off-spec (small) fraction of Aktobe plant of production of silica brick.

RESULTS

According to the research use of the proposed new structure and processing technologies allow to:

- To increase the length of seedlings in 3 - 4 times.

- To increase the total biomass of green seedlings in 3.5 times
- To increase biometrics by 4-5 times, and in some cases by 5.5 times.
- To increase germinating ability in 1.5 times, and vigor in 2 times.
- To reduce the cost of the process and operating costs through the use of waste.

Economic efficiency made:

$E_e = 10^4 \times 10^3 \times 1 \times 0,5 = 5$ million $ in year

here:

10^4 m^3 – volume of the processing waste water in a year;

0,5 – 50 % overhead costs;

conditional price for 1 l of the waste water is – 1 $.

Vegetables and green material are obtained by the method of spraying fertilizer BMF safe-ended and non-toxic.

CONCLUSIONS

Recycling wastewater on bore micro fertilizers allows along with creating a base for the production of micronutrients needed by rural and individual farms and produce economic benefits, recycle hazardous waste.

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